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Docket No. 1509-455

PATENT

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In re Application of	:	Confirmation No. 8999
Stephen Philip CHEATLE	:	Group Art Unit: 2872
Serial No. 10/697,874	:	Examiner: Not assigned
Filed: October 31, 2003	:	

For: IMAGE CAPTURE SYSTEM AND METHOD

SUBMISSION OF PRIORITY DOCUMENT

Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

At the time the above-identified application was filed, priority was claimed based on British Application No. 0225406.8, filed October 31, 2002. A copy of the priority application is attached. The Examiner is courteously requested to acknowledge Applicant's claim for priority and receipt of the certified copy of the priority document.

Respectfully submitted,

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1. Your reference — 200206484-1 GB

2. Patent application number *(The Patent Office will fill in this part)* — 0225406.8 — 31 OCT 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   Hewlett-Packard Company
   3000 Hanover Street
   Palo Alto
   CA 94304, USA

   Patents ADP number *(if you know it)* — 496588001

   If the applicant is a corporate body, give the country/state of its incorporation — Delaware, USA

4. Title of the invention — Image Capture System

5. Name of your agent *(if you have one)*

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   Richard A. Lawrence
   Hewlett-Packard Ltd, IP Section
   Filton Road, Stoke Gifford
   Bristol BS34 8QZ

   Patents ADP number *(if you know it)* — 7448038001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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11. I/We request the grant of a patent on the basis of this application.

Signature Richard A. Lawrence Date 31/10/02

12. Name and daytime telephone number of person to contact in the United Kingdom — Meg Joyce Tel: 0117-312-9068

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Image Capture System

This invention relates to an image capture system and to a method of controlling an image capture device and to a method of capturing an image with an image capture device.

A head mounted camera has the advantage that it is pointing in the same direction as the wearer is facing. Consequently, the camera "sees" roughly what the wearer is looking at. However, a significant disadvantage of head mounted cameras is that a camera has to be pointing in the same direction as the face and as a consequence is generally visible. Potential wearers of cameras tend to be concerned about their facial appearance and are reluctant to have large pieces of technology attached to their heads. Attempts have been made to miniaturise wearable cameras and disguise them in glasses or hats. These approaches are only partially successful and tend to result in serious compromises in image quality.

A further problem relates to the electronics associated with the camera. All wearable cameras require some form of power supply, image processing and storage or data transmission. Typically, these additional functions are located elsewhere about the wearer's body, connected to the image sensor by a cable for example. The cable connection makes wearable cameras inconvenient to put on and take off. It is also unsightly, requiring the wearer to go to some trouble to conceal it. Proposals for a wireless connection between a camera head and the associated electronics generally impose severe bandwidth restrictions, which make high quality still or video capture very difficult.

Attempting to conceal a head mounted camera in order to prevent it detracting from the wearer's appearance can easily be misconstrued as an attempt to take covert pictures. This has negative social implications which overt cameras do not suffer from.

It is an object of the present invention to address the above mentioned disadvantages.

According to a first aspect of the invention an image capture system incorporates a body-mountable image capture device, a head motion detector, a body motion detector and control means, wherein the control means is operable to take body and head motion signals from the head and body motion detectors respectively, to measure motion of a user's head with respect to his body, and wherein the control means is operable to move a field of view of the image capture device according to the measured motion of the user's head with respect to his body.

The body-mountable image capture device is preferably a camera and is preferably adapted to be secured to a user's body, for example his chest or shoulder.

The control means may be a computing device. The control means is preferably incorporated in or a part of the image capture device.

The control means is preferably operable to control an image capture device adjustment section, which may be a pan/tilt mechanism, in order to move a field of view of the image capture device, preferably by an amount

corresponding to the measured head motion, relative to the user's body.

The control means is preferably operable to cause the image capture device adjustment section to move the field of view of the image capture device by an amount greater than the measured relative head motion. The image capture system thereby advantageously takes account of movement of the user's eyes with respect to his head.

The head motion detector is preferably operable to be secured to the user's head, preferably as a piece of headgear or a part thereof. The head motion detector is preferably operable to detect lateral rotation of the user's head. The head motion detector may be operable to pass signals to the control means by a wireless link.

The body motion detector may be incorporated in or is a part of the image capture device, or may be a part of the image capture device adjustment section. The body motion detector is preferably operable to detect lateral motion, preferably lateral rotation, of the user's body.

The image capture system may incorporate a distance sensor, operable, in conjunction with a known distance from the user's eyes to the image capture device, to compensate for a parallax error between the two.

The image capture system may include calibration means that are operable to calibrate a forward direction for the motion detectors, based on an average output of the motion detectors being adjusted to substantially no offset between a direction the user's head and body are facing.

The image capture device may incorporate a tilt detector, operable to adjust the image capture device to account for a tilting away from the horizontal of the image capture device.

According to a second aspect of the invention a method of controlling an image capture device comprises:

detecting motion of a user's head using a head motion detector;

detecting motion of a user's body using a body motion detector;

measuring motion of the user's head with respect to his body using control means, which control means take body and head motion signals from the body and head motion detectors respectively; and

moving a field of view of an image capture device secured to the user's body according to the measured motion of the user's head with respect to his body.

The image capture device is preferably secured to the user's trunk, preferably to his chest or shoulder.

The body motion detector is preferably secured to the image capture device, or to an image capture device adjustment section.

For a better understanding of the invention and to show how the same may be brought into effect, specific embodiments will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic front view of a user wearing a chest-mounted camera and a head mounted motion sensor; and

Figure 2 is a schematic view from above of the arrangement shown in Figure 1.

A camera apparatus 10 incorporates a head mounted motion sensor 12 and a camera 14 mounted on a pan/tilt unit 16 (see Figure 2) secured to a user 18. The camera 14 also includes a motion sensor 20.

The head mounted motion sensor 12 and the body mounted motion sensor 20 are used to detect side to side motion of the user's head and body respectively. Such side to side motion may be a rotational motion. The motion sensors 12 and 20 may also optionally be used to detect up and down motion of the user's head and body respectively.

The motion sensors 12 and 20 may make use of mechanical motion sensors. These may be in the form of micro-compasses which give an absolute measure of the direction in which the respective motion sensors 12 and 20 are pointing. Suitable calibration to a forward direction (for example with respect to a casing of the motion sensor 12/20) can be used to provide an angle of deviation from forward to indicate how a user's head or body has moved. A suitable type of compass would be a Hall effect type. A specific example of compass would be a Honeywell HMR 3200 model which has an accuracy of approximately half a degree.

An alternative type of motion sensor 12, 20 would be a gyroscope, such as the Murata ENC 03J. This is a

piezoelectric type device which makes use of a vibrating column, which column goes off axis when the device is moved to create a detection current.

The output of the motion sensors 12, 20 is in the form of a value for an angle through which the sensor has moved. A practical example may be where a user turns to one side moving his head through 45° and moving his body through 25°, both with respect to an independent axis. A difference unit (which may be a control portion, implemented with a microcomputing device) 22 receives outputs from the body mounted motion sensor 20 and the head mounted motion sensor 12. The head mounted motion sensor 12 may communicate its output via a wireless link, such as Bluetooth link. The difference unit 22 then simply subtracts the body mounted motion sensor value from the head mounted motion sensor value to obtain a value of 20° for the movement of the user's head relative to his body. This value provides an angle through which the camera 14 should turn in order to follow movement of the user's head. Thus, the difference unit 22 sends a signal to the pan/tilt unit 16 to turn by 20°, the amount of the calculated difference from the difference unit 22.

In this way, a camera can advantageously be worn on a user's body, but at the same time motion of his head with respect to his body is detected and accounted for in the motion of the camera 14, which follows the direction that his head is facing.

Upward and downward motion of the user's head can also be detected, possibly with a differently orientated motion sensor to detect up/down movement of the head rather than

side to side movement. Then, the pan/tilt mechanism can be moved up/down as required, in the same way as described above. Furthermore, a third degree of rotational freedom may be accounted for using an additional motion detector that detects tilting of a user's head to one side. A combination of pan and tilt can be used to compensate for such motion.

An additional feature of the camera apparatus 10 would be self-calibration means incorporated in the control portion to perform self-calibration of the head mounted motion sensor 12 and the motion sensor 20 on the basis that for the majority of that time the user's head will be pointing in the same direction as his body. Thus, the mean output of the difference signal from the difference unit 22 is adjusted to be 0°, i.e. straight ahead. Thus, by taking an average over time of the difference signal calibration is achieved.

The body mounted motion detector 20 may also incorporate a tilt detector in anticipation of the camera drooping forward on its mounting. Data from the tilt detector is fed to the pan/tilt mechanism to ensure that the camera 14 points forwards on a horizontal axis, except of course when head motion dictates that the camera is tilted up/down.

A further optional extension of the functionality of the camera apparatus 10 would be to combine the results of the approximate direction that the user's head faces (based on signals from the head mounted motion sensor 12 and the body mounted motion sensor 20) with aspects of stabilisation and attentional control that are disclosed

by Mayol, WW et al, Wearable Visual Robots, in IEEE International Symposium on Wearable Computing, ISWC'00 Atlanta, October 2000. The stabilisation and attentional control described in Wearable Visual Robots allows the camera apparatus 10 to provide its own stabilisation of areas or objects of interest, whilst still being controlled by motion of the user's head. The Mayol disclosure has its aim of "decoupling of camera movement from the wearer's posture and motions", whereas the intention of present embodiments is to achieve the opposite. Nevertheless, the stabilisation and attentional control disclosed by Mayol would be an optional addition of functionality to the camera apparatus 10 disclosed herein.

The camera apparatus 10 may incorporate a distance sensor 24 used to determine the distance to the subject. If the distance is known, together with an estimated or pre-calibrated distance between the camera 14 and a user's eye, the camera's direction of view can be adjusted to remove potential parallax errors. Parallax errors will be reduced when the user 18 wears the camera 14 centrally, thus isolating a parallax error to an up/down tilt direction.

A co-pending application of the same applicant is annexed hereto and is incorporated herein by reference. The features of the image capture system described in that application can also be advantageously used in the system described herein. When motion of the user's head relative to his body is detected the camera 14 can be moved by the detected amount and also by an additional amount to

account for movement of his eyes with respect to his head. Further details can be found in the annex.

The camera apparatus 10 described herein advantageously allows a camera to be worn on a user's body, but at the same time the camera 14 is caused to follow motion of the user's head to approximate a direction in which the user's head is facing. Thus, a user is freed from the necessity of wearing a camera on his head, because motion of his head is detected by a very small, unobtrusive motion sensor 12, signals from which can be transmitted wirelessly to the camera 14 which can be conveniently located on his chest for example or his shoulder.

ANNEX

Image Capture Systems using Motion Detection

This invention relates to an image capture system that uses at least one motion sensor.

It is known for a user to wear a head mounted camera, which points in the direction that the user's face is facing, so that images can be captured of roughly what the user is looking at.

This type of set-up does not allow for the user moving his eyes relative to his head, causing resultant images to often be poorly framed.

Head-mounted cameras are well known, such as that described in WO9949656 (Mann). The system described in Mann assumes that the head direction is the correct direction for image capture. Any control of what is captured needs to be done by consciously pointing the head in the direction of interest. Sophisticated wearable camera systems such as described as Mann, are coupled with a wearable view finder to provide the wearer with confirmation that what the camera is seeing is what is required.

In Wearable Visual Robots (IEEE International Symposium on Wearable Computing, ISWC'00, Atlanta, October 2000) a wearable visual robot is disclosed having a pan/tilt mechanism. The work described mounts the apparatus on a wearer's shoulder. The device has motion sensors attached to it, but there are no sensors attached to the wearer's head, so the device is unable to take into account the

motion of the wearer's head. The aim of the approach in this document is to provide a sensor which "decouples camera movement from the wearer's posture and movements". The aim is to allow the robot itself to choose what to look at. The motion sensors are provided to increase its ability to stabilise its line of vision on what the robot decides should be captured, regardless of where the user's attention is focussed.

Several alternatives have also been proposed for capturing a panoramic image of a scene. These include US 614034 which discloses a dodecahedral arrangement of sensors whose images can be combined into a single panoramic image. Also, US 6356296 describes the use of a parabolic reflector to capture an entire 180° angle of view using a single sensor. The aim of both of these systems is to provide a very wide angle of view image. A problem arises with panoramic view capture in that it is not clear what part of the image is of interest. Typically a panoramic view will not all be interesting, but merely a part thereof.

It is an object of the present invention to address the above mentioned disadvantages.

According to a first aspect of the invention an image capture system incorporates an image capture device and head motion detection means operable to detect motion of a user's head; wherein the image capture system is adapted to move a direction of a field of view of the image capture device relative to the user's head, based on detected motion of the user's head.

The image capture device is preferably operable to be mounted on a user's head.

The head motion detection means are preferably adapted to be secured to a user's head.

The image capture system may be adapted to move, preferably rotate, the field of view of the image capture device relative to a direction of view of the user's face.

The head motion detection means may be mechanical head motion detection means, preferably at least one gyroscope and/or at least one compass.

The head motion detection means may be image analysis means operable to determine a motion of an object within a field of view of the image capture device to infer motion of a user's head.

The head motion detection means may incorporate a centering mechanism, which preferably takes as a centre position a position adopted by the motion detection means for a majority of the time.

The image capture system is preferably operable to control a direction of view of the image capture device with field of view control means, preferably to control a field of view by a lateral rotation.

The field of view control means may control at least one additional image capture device, preferably a lateral additional image capture device, preferably two lateral additional image capture devices. A lateral image capture

device may be an additional image capture device, preferably positioned such that an optical axis thereof is rotated in a horizontal plane relative to that of the first mentioned image capture device, preferably thereby having a field of view which is horizontally rotated from the field of view of a main image capture device.

The or each lateral additional image capture device preferably has a field of view to one side of a main image capture device that substantially partially overlaps with a field of view the main image capture device.

Images from the main and additional image capture devices may be buffered in a storage means for subsequent retention of an image/images from one of said image capture devices.

The field of view control means may comprise a mechanism operable to adjust a direction of the image capture device, preferably to adjust the direction from side to side. The mechanism may be a pan adjustment mechanism, or may be a pan/tilt adjustment mechanism.

The field of view control means may comprise at least one mirror operable to be adjusted to adjust an image reflected to the image capture device. Preferably, the field of view control means comprises two mirrors. The field of view control means may be operable to adjust the or each mirror to move the image reflected to the image capture device laterally.

The field of view control means may be operable to select a smaller image from a first image captured by the image

capture device. Said first image may be an image of substantially all of a user's lateral field of view, including the user's view with his eyes moved to one or both sides. The image capture device may incorporate a wide-angle lens, which may be a fish-eye lens.

The image capture system may incorporate control means, which may be a computer or microcomputer, operable to activate the field of view control means on detection of movement of the user's head. Preferably, on detection of movement of the user's head in a first direction by the head motion detection means, the control means is operable to activate the field of view control means to move a direction of view of the image capture device in the first direction, by an amount in addition to the detected head motion.

An amplitude of movement of the user's head detected by the head motion detection means may be used to control an amplitude of movement of the direction of view of the image capture device in addition to the detected head motion. The amplitude of movement of the field of view may be chosen to be of substantially the same amplitude as the amplitude of detected head movement.

A direction of detected head movement may be used to select an additional or lateral image capture device for providing the field of view.

According to a second aspect of the invention a method of capturing an image with an image capture device, comprises:

detecting motion of user's head; and

offsetting a field of view of an image capture device in a direction of the detected motion of the user's head.

The image capture device may be secured to the user's head.

Preferably, the detected motion is a rotation of the user's head, preferably a lateral rotation, to left or right.

The field of view may be offset by an amount derived from an amplitude of the detected motion, preferably in the range of approximately 30° to approximately 45°.

All of the features described herein may be combined with any of the above aspects, in any combination.

For a better understanding of the invention and to show how the same may be brought into effect, specific embodiments will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic front view of an image capture device incorporating three separate image sensors pointing at different angles and incorporating a motion sensor, for wear as a pair of spectacles;

Figure 1b is a schematic view from above of the device shown in Figure 1a;

Figure 2a is a schematic view from the front of an image capture device having a pan/tilt mechanism for adjusting

the field of view of the device, together with a motion sensor;

Figure 2b is a schematic view from above of the device than in Figure 2a; and

Figure 3 is a partial schematic view of an alternative arrangement of image capture device having a switchable direction of view by means of pivotable mirrors;

Figure 4a is a schematic view from above of a camera having a fish-eye lens; and

Figure 4b is a schematic view and field of view selection from a larger image.

It has been realised that when a person turns his head to look at a new stimulus his eyes are typically moved more quickly than his head so that as he looks to the side his eye movement, combined with the head movement, rotates his direction of view by up to twice the angle of the head rotation alone. If a camera is fixed to a user's head then it will only rotate by the head movement, which results in the camera no longer capturing approximately what the wearer is looking at. Below are described various embodiments by which an image sensing means can offset the direction of view of a captured image from the direction of a user's head, such that the direction of the image capture rotates in the same direction as the head, but by a larger angle. This accomplished by sensing the rotation of the user's head, detecting when a turn to the left or right is occurring and moving the angle of view of the image sensing means so that it rotates further than

the rotation of the head alone, in the same direction as the head rotation.

The embodiments described disclose a system that adjusts the direction of image capture to take into account eye motion, rather than simply relying on head direction. This frees a user from having to think about what is being captured, because the wearable camera system will generally be capturing the area of visual attention more accurately than a conventional head mounted camera.

The embodiments described below all require the head rotation detection mechanism to control an additional change in the direction of view of the captured image beyond mere movement of the user's head. Also, an image capture device having a controllable field of view is required.

In relation to head rotation detection a first head rotation detection mechanism 10 is shown in Figures 1a and 1b mounted on a pair of spectacles 12 to be worn by a user 14. The head rotation detection mechanism 10 makes use of a mechanical motion sensor.

This may be in the form of a micro-compass which gives an absolute measure of the direction in which the detection mechanism 10 is pointing. Suitable calibration to a forward direction can be used to provide an angle of deviation from forward to indicate how much a user's head has moved. A suitable type of compass would be a Hall effect type, which may have a low accuracy as low as 45°, but may be sufficient to indicate that a person's head has moved to either right or left. Such a low accuracy device

has the benefit of low cost. A more accurate compass would be a Honeywell HMR 3200 model, which gives a half degree accuracy.

An alternative type of head rotation detection mechanism device 10 would be to use a miniature gyroscopic device, such as a Murata Enc 03J, which is of a piezoelectric type, in which a vibrating column is moved off-axis by acceleration of the device, which movement off-axis causes current to flow in a piezoelectric device. With a gyroscope, the rate of movement need only be integrated to revert to an angle through which the accelerator has rotated. The amount of rotation is determined by integration of the signal.

The output of an accelerometer type gyroscope will provide a peak in a first, e.g. positive, direction for a leftward rotation of the user's head and a second, e.g. negative, peak for opposite, rightward direction of the user's head. These would provide positive and negative values for an integral of the signal. Thus, left and right motion can easily be determined by a positive value for leftward movement and a negative value for rightwards movement. The amount of the integral provides the amplitude of the rotation in that given direction.

Normally, in use, following a rotation of his head, a user 14 will return his head to the central position with his head pointing forward. In addition, a user will typically have his head pointing forwards for the majority of the time. Both of these facts can be used to provide a resetting mechanism for the head rotation detection mechanism 10 which can be set to have the forward

direction as the direction used for the majority of the time.

An alternative method by which head rotation can be detected would be to use the analysis of high frame rate imagery from a camera view in line with the user's head in order to detect head rotation from the motion field of the video. Taking a camera 16 as shown in Figure 1a, which captures images at a high frame rate, movement of the image is detected. For example images may be coded with an MPEG standard, in which a difference between successive images is calculated and coded, rather than coding the whole image for each "frame". By taking a crude average of the position of selected blocks within an image and analysing how those blocks move across the screen, an estimate of head rotation speed can be obtained. More specifically, corner points or edges of objects within the field of view can be detected and located and then tracked across the field of view to give an estimate of an amount rotation of a user's head. This latter method would need a reasonable degree of focus in order to be able to detect corner points. Further information can be obtained from Comparing and Evaluating Interest Points; Cornelia Schmid, Roger Mohr, and Christian Bauckhage; INRIA Rhône-Alpes, 655 ar d'L Europe, 28330, Montbonnot, France.

Together with detection of head motion/rotation, it is also necessary to have a controllable field of view for image capture. A number of alternatives are possible.

The first alternative is to use multiple cameras angled in fixed orientation such that a captured image can be switched automatically from one to other camera, with the

possibility of forming a view from an intermediate angle of view by forming a composite from parts of an adjacent pair of cameras. Figure 1a and Figure 1b show a central camera 16, a left camera 18, and a right camera 20 having the fields of view shown schematically in Figure 1b. The fields of view clearly overlap.

The embodiment shown in Figures 1a and 1b would typically be used by recording the central camera 16 when a wearer's head is not rotating, with the other cameras 18 and 20 being ignored. When rotation of the user's head to the left for example is detected by the motion detection device 10 recording the image is switched to camera 18. When the user's head returns to the centre position, as detected by the motion detector sensor 10, recording is switched to the central camera 16. Similarly, when a right turn of the head is detected recording is switched to the right camera 20 and back to the central camera 16 when the user's head moves back to the centre position.

The pair of spectacles 12 shown in Figures 1a and 1b carries the three cameras 16, 18 and 20 and the motion detection device 10. The motion detection device may be located on an arm 13 of the spectacles to be less obtrusive. Also, a control and image recording apparatus 22a may be located on the glasses. Alternatively, images may be transmitted to a remote control and image storage section 22b, for example by a wireless link, such as a Blue Tooth link, or by a wired link.

Typically, the spectacles 12 incorporating the cameras 16, 18, 20 and motion detection means 10 will continuously capture images from one of the cameras 16, 18, 20. Frames

may be deliberately dropped when there is excessive head motion if the exposure time cannot be kept sufficiently high to avoid motion blur. The frames may be stored continuously as a video, or they may be held in a temporary rolling buffer such that a predetermined number of the last images is recorded. In this case, the user would typically signal to the camera when something that should be recorded had just been observed. On receiving the signal the control/storage apparatus 22a or 22b would transfer the current contents of the rolling buffer to its permanent storage, also located in the control/storage section 22a/22b.

Normally, following a rotation of the head, the camera wearer will return his head to the central position within a short time. This can be detected by the head rotation sensor 10 to cause the image capture to revert to the centrally positioned camera 16. If a return rotation is not detected within a short time, typically in approximately 2 seconds, the controller/storage apparatus 22a/b automatically returns to recording of the central view from camera 16, because it is unlikely that the wearer will keep his eyes far from straight for a prolonged time. Instead, the body is likely to be turned towards the direction of interest.

This automatic return to centre may be implemented by a simple time-out mechanism. Alternatively, the system may revert to centre when it has a high confidence that an image of acceptable quality has been captured, looking in an extreme direction. Such a confidence measure can be a function of camera motion, exposure and focus parameters for example, by which it may be determined whether the

camera has been stationary for long enough for a suitable image to be captured.

The multiple sensor implementation shown in Figures 1a and 1b has the advantage that images from the side views can be captured immediately. This is typically important because it is likely to have been an interesting event which the wearer saw "out of the corner of his eye" which attracted his attention and hence gave rise to head rotation. A camera that is already pointing in the correct direction has a high chance of capturing an image of the event.

Still further, the latter advantage may be further improved by implementing the system so that each of the three cameras 16 to 20 in Figures 1a/b is locally buffering images to the storage/control section 22a/b, with only one camera output being retained. When inputs to the system of the motion sensors to control section 22a/b indicate that images should be captured the buffered images could be taken from a time fractionally earlier than the detection time. In this way, the view that caused the user to turn his head will be caught before he actually turned.

The advantages of the embodiment shown in Figures 1a/b could be improved by using sufficient cameras with overlapping fields of view that at least one of them will always capture an image which has reasonable framing. If an insufficient number of cameras is used, then framing may not be adequate. Also, a sufficiently fast exposure should be used such that images free from motion blur are captured even whilst the user's head is rotating. In this

way, an acceptably cropped still image will be obtained by at least one of the frames captured during the head rotation. Alternatively by using the three cameras shown in Figures 1a and 1b frames may be combined from adjacent cameras by using any of the well-known mosaicing techniques in order to generate an image with an intermediate direction of view, but which is better framed.

As an alternative to the three cameras 16 to 18 shown in Figures 1a/1b, it is possible to arrange a pan/tilt mechanism 24 for a camera 26 to be mounted the user's head, as shown in Figures 2a/b. A pan/tilt mechanism similar to the one described in Wearable Visual Robot (above) could be used.

The pan/tilt mechanism 24 is controlled in the same way that camera selection is made in the previous example, except that when a side view (left or right) is required the pan/tilt mechanism 24 moves the camera 26 to the side by a given angle. The angle use may be approximately in the range of approximately 30° to approximately 45°, which corresponds to an angle through which a user's eyes may typically move when glancing sideways to follow a movement.

A further alternative would be to use a system shown in Figure 3 by which first and second fixed sensors 28 and 32 have an optically rotatable or switchable direction of view. This system is effectively like a periscope on its side, with a moveable mirrors 30 that can be rotated (as shown by the arrows) in order to change the image that is reflected towards the sensors 28/32 from a view V. The

two sensors 28/32 may face towards a centre part of the spectacles shown in Figure 4a. The mirror 30 (or a mirror for each sensor) may be rotated to change the field of view reflected to the sensors 28/32. Mirror 28 may reflect for a right hand field of view and the other mirror (not shown) for a left hand field of view. An alternative arrangement would use a single mirror.

For the embodiment described above, the arrangements described in Figures 2a, 2b and 3 have the advantage that the number of components is reduced, fewer image sensors are required. However, there may be some time lag disadvantage with this embodiment, because of the time required to sense the need for movement to one side and the time to achieve that movement.

A further alternative for controlling the field of view of the image capture device, would be to have automated cropping of an image from a camera 40 with a very wide field of view 42 (see Figure 4a). This would need a high resolution sensor 44 and would also typically use a fish-eye lens 46 or the like. A window of interest 48, as detected and defined by a user's head motion in the manner described above could then be moved across the captured field of image 42 to retain that part of the image which is decided to be of interest.

An advantage of this latter controllable field of view is that there are no moving parts. In the function required by the system described herein good image quality is required at the periphery of an image also, because that may become the centre of a chosen field of interest 48 within the image 42.

A more sophisticated implementation of the systems described above would be to include an additional mechanism for detecting rotation of the user's body. Such a mechanism would allow head motion relative to the body to be identified. The mechanism used would be the same as that used to detect head rotation, but merely secured to the user's body instead of his head. This would allow the head motion relative to the body to be identified. With this embodiment an offset view angle can be chosen on the basis of the measured head rotation relative to the measured body rotation. This embodiment has the advantage of being a more accurate indicator of when the additional rotation of view should be started and terminated, because it may be used to prevent inappropriate changes to the camera field of view. For example if a wearer is walking around a corner, he may look straight ahead so no change of the field of view is required. The addition of a body rotation sensor allows this situation to be differentiated from that of a head turn alone, the latter signifying a change of view.

Another use of this embodiment is in the case where the head turns initially relative to the body, but the body then turns by a matching amount, so that head and body are facing the same way. The time at which the body "catches up" can signify that the focus of attention has reverted to straight ahead, so the additional rotation of the camera's field of view can be terminated when this condition is detected, if it has not been detected earlier.

It would be optional for any of the methods for capturing images described above to be left as a final choice to a user, or a best frame technique could be used to automatically pick the angle of view which best frames a probable subject.

All of the embodiments described above advantageously provide means by which a user can automatically capture an image of a subject of interest to which his attention is drawn and to which he is moving his eyes relative to movement of his head.

CLAIMS:

1. An image capture system incorporates a body-mountable image capture device, a head motion detector, a body motion detector and control means, wherein the control means is operable to take body and head motion signals from the head and body motion detectors respectively, to measure motion of a user's head with respect to his body, and wherein the control means is operable to move a field of view of the image capture device according to the measured motion of the user's head with respect to his body.

2. An image capture system as claimed in claim 1, in which the body mountable image capture device is a camera adapted to be secured to user's body.

3. An image capture system as claimed in either claim 1 or claim 2, in which the control means is a computing device.

4. An image capture system as claimed in any preceding claim, in which the control means is operable to control an image capture device adjustment section, in order to move a field of view of the image capture device.

5. An image capture system as claimed in claim 4, in which the image capture device adjustment section is operable to move the field of view of the image capture device by an amount corresponding to the measured head rotation, relative to the user's body.

6. An image capture system as claimed in claim 4 or claim 5, in which the control means is operable to cause the image capture device adjustment section to move the field of view of the image capture device by an amount greater than the measured relative head motion.

7. An image capture system as claimed in any preceding claim, in which the head motion detector is operable to be secured to the user's head.

8. An image capture system as claimed in claim 7, in which the head motion detector is operable to detect lateral rotation.

9. An image capture system as claimed in any preceding claim, in which the body motion detector is incorporated in, or is a part of, the image capture device.

10. An image capture system as claimed in any preceding claim, which incorporates a distance sensor, operable, in conjunction with a known distance between the user's eyes and the image capture device, to compensate for a parallax error.

11. An image capture system as claimed in any preceding claim, in which calibration means are operable to calibrate a forward direction for the motion detectors based on an average output of the motion detectors being adjusted to substantially no offset between a direction the user's body and head are facing.

12. An image capture system as claimed in any preceding claim, in which the image capture device incorporates a

tilt detector, operable to adjust the image capture device to account for a titling away from the horizontal of the image capture device.

13. A method of controlling an image capture device comprises:

detecting motion of a user's head using a head motion detector;

detecting motion of a user's body using a body motion detector;

measuring motion of the user's head with respect to his body using control means, which control means take body and head motion signals from the body and head motion detectors respectively; and

moving a field of view of an image capture device secured to the user's body according to the measured motion of the user's head with respect to his body.

14. A method as claimed in claim 13, in which the image capture device is secured to the user's trunk.

15. A method as claimed in either claim 13 or claim 14, in which the body motion detector is secured to an image capture device adjustment section.

16. A image capture system substantially as described herein with reference to the accompanying drawings.

17. A method of control an image capture device substantially as described herein with reference to the accompanying drawings.

Abstract

Image Capture System

An image capture system (10) incorporates a body mountable image capture device (14), a head motion detector (12), a body motion detector (20) and control means (22), wherein the control means (22) is operable to take body and head motion signals from the head and body motion detectors (12,20) respectively, to measure motion of a user's head with respect to his body, and wherein the control means (22) is operable to move a field of view of the image capture device according to the measured motion of the user's head with respect to his body.

[Figure 1]

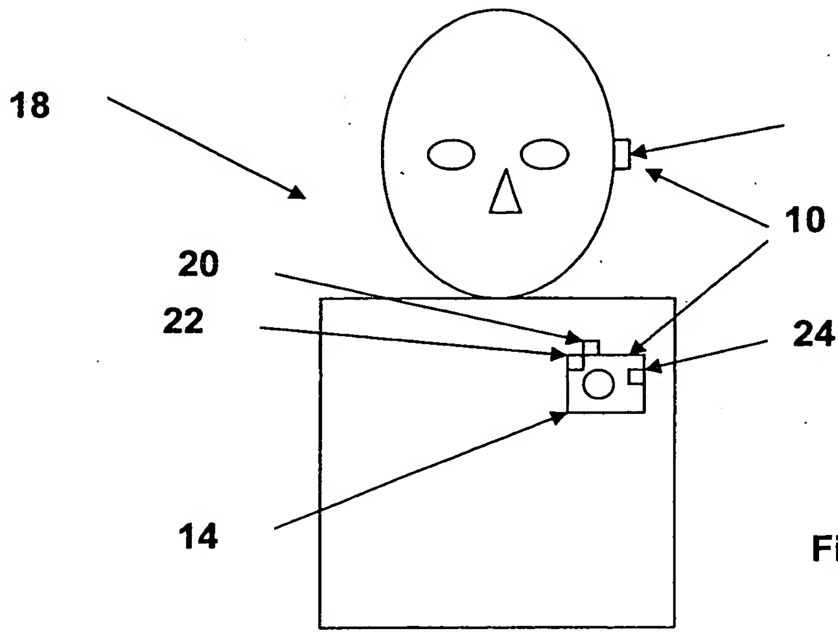


Fig. 1

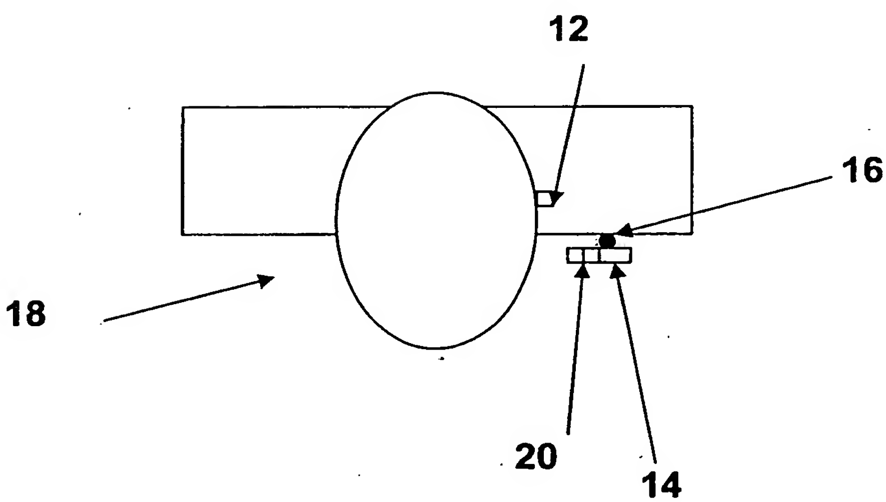
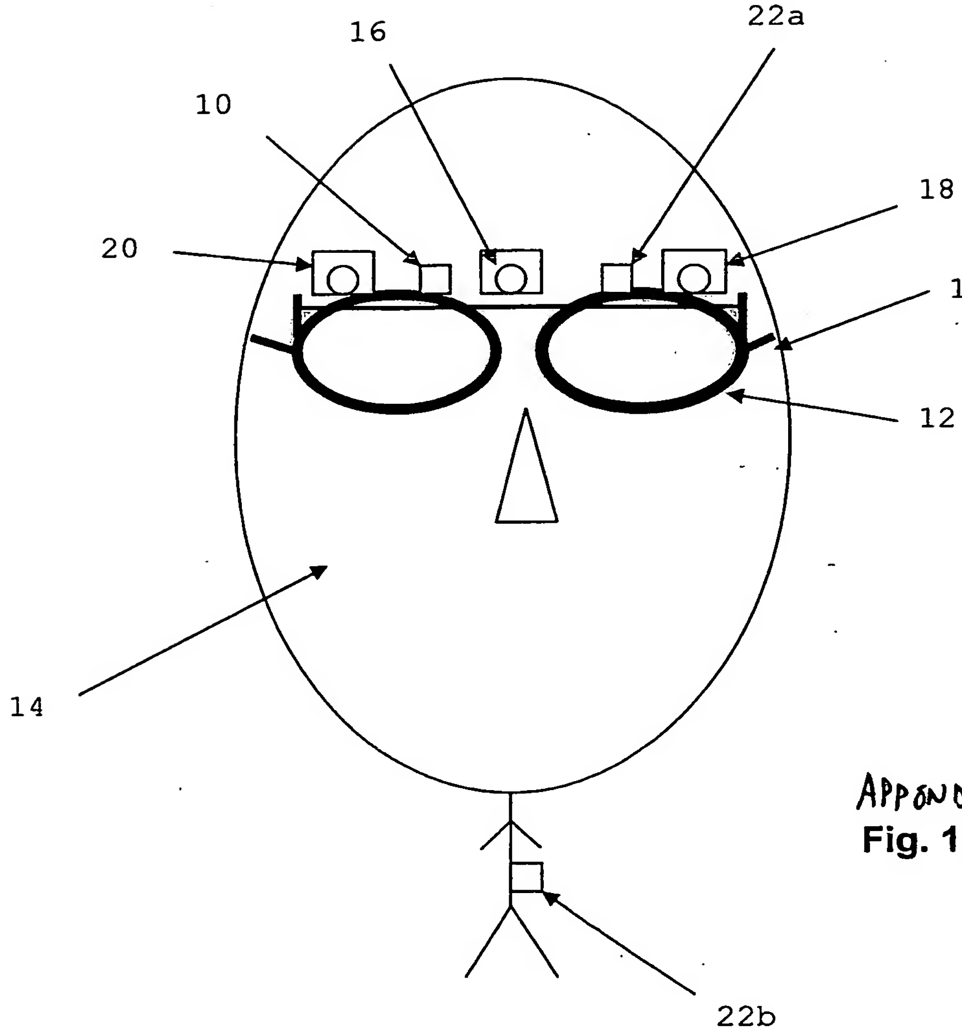
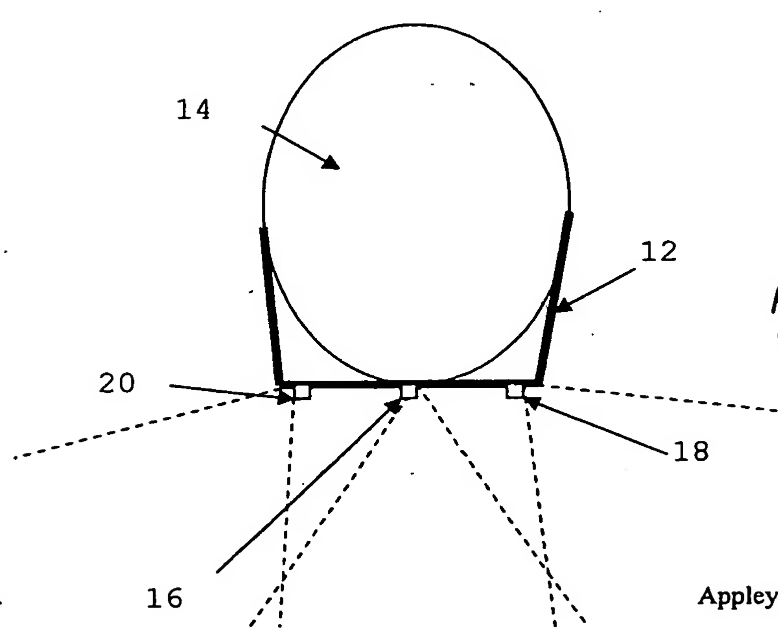


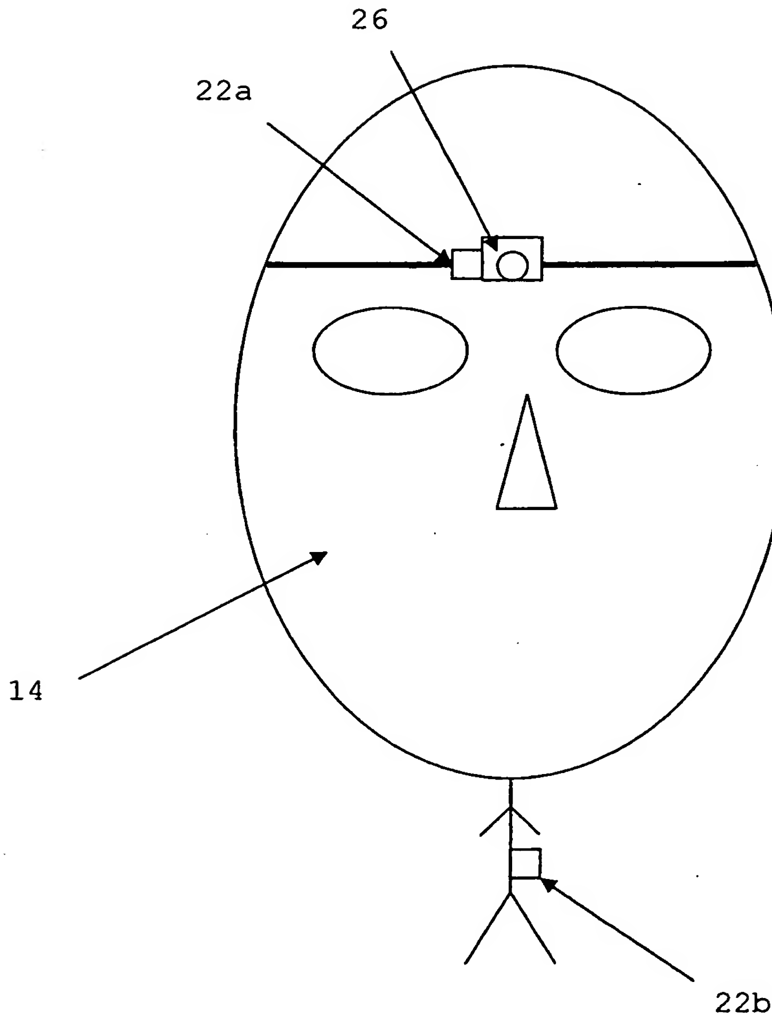
Fig. 2



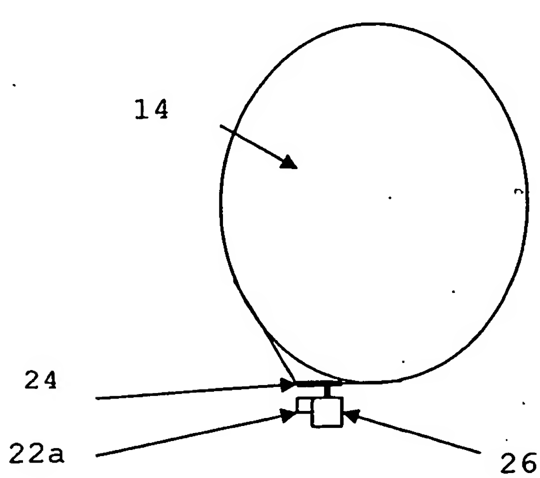
APPONDIX
Fig. 1a



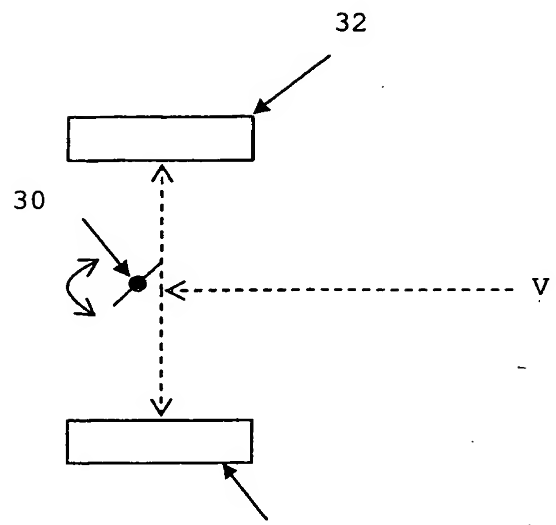
APPONDIX
Fig. 1b



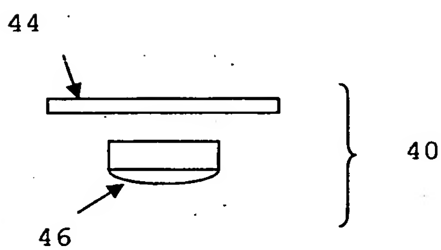
Appendix
Fig. 2a



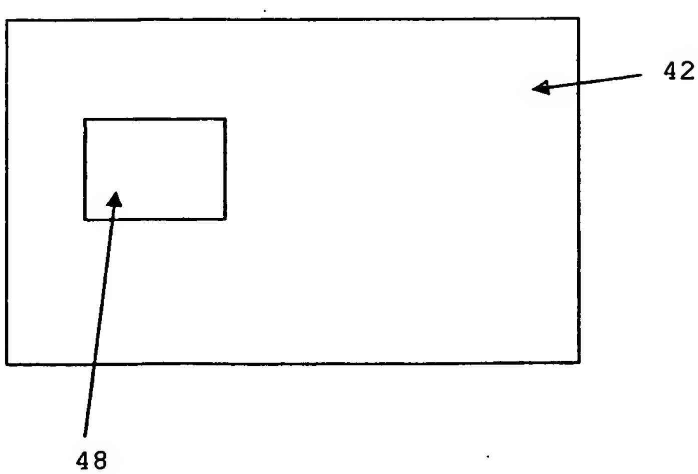
Appendix
Fig. 2b



APPONDIX
Fig. 3



APPONDIX
Fig. 4a



APPONDIX
Fig. 4b